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ABSTRACT

The use of word processing and digital image processing to develop new methods for preparing and evaluating materials in the Open University and the implications of these developments are discussed. Recent developments in computer and educational technology are reported as they pertain to cost effectiveness both in production efficiency and educational effectiveness. In addition to discussing experiences with current developments, new or soon-to-be commercially available word processing technologies are described. Characteristics of the next generation of word processing, such as large- screen, multi-font, proportionally-spaced displays, that aid in manuscript preparation, are discussed, as well as semi-automatic house-style implementation and checks on vocabulary. (CHC)

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COMPUTER ASSISTANCE IN MULTI-MEDIA
EDUCATIONAL PUBLISHING

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IET Text-Processing Paper 2

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Computer assistance in multi-media educational publishing

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ABSTRACT

The Open University is well-known for its multi-media approach to home-based study; the typical course is a compendium of conventional and structured texts, radio and television programmes, and many other components.

Although cost-effective, such courses have tended to be both labour- and capital-intensive. Recent developments in computer and educational technology appear to offer considerable improvements not only in production efficiency but also in educational effectiveness.

Accordingly, while continuing to experiment with new components (e.g. simultaneous computer-assisted learning and telephone instruction, and interactive television), the University has also been assessing and adapting existing technologies (e.g. word processing and digital image processing) to develop new methods for preparing and evaluating its materials.

We shall report in some detail on these developments and their implications, drawing upon both our experiences with a current course and our knowledge of what is either actually or soon-to-be commercially available.

Thus, to take the example of word processing, current machines passively preserve a writer's words, but the next generation will not only have better 'conventional' facilities, such as large-screen, multi-font, proportionally-spaced displays, but will actively aid manuscript preparation. Simple aids, such as those we are experimenting with, include semi-automatic house-style implementation and checks on vocabulary. More complex aids would draw upon recent work in cognitive and information science, and their availability would alter work-patterns considerably.

Over 65 000 adults, many without previous academic qualifications, are currently enrolled as students of the British Open University. Their study is home-based, rather than campus-based, and the multi-media teaching we offer them includes correspondence texts and radio and television programmes.

As you will hear in John Cox's paper (The impact of Open University Methodology in the less developed world), the majority of our courses are produced by 'course teams': groups of academics, designers, editors, producers and other specialists who combine their expertise. This labour-intensive method of producing and evaluating our courses is only economic if we can rely on economies of scale (e.g. long print-runs).

However, whilst our introductory (foundation) courses are exceedingly cost-effective, many of our more advanced courses have much smaller enrolments, although there may be very little difference between the overheads of different courses (e.g. the 'maintenance' load, caused by the yearly need to write new computer-marked or tutor-marked assignments, etc). Even the advantage of long print-runs can disappear if some parts of a course date rapidly.

One way round this problem (the increasing unit cost of producing and presenting our material) is to collaborate with other institutions; this effectively

increases the size of our audience, and also introduces the possibility of outside funding for co-productions.

Another way is to re-assess our existing course-production methodology, to see whether it is possible to maintain our educational effectiveness, whilst reducing either the costs of storing, altering and delivering our material, or reducing staff input (academics, designers, editors, etc). This latter approach (reducing staff input) has led to the appearance of several 'low-resource' courses which are based upon (and written around) existing text-books or other previously published material. Clearly, if one can find a well-written text, this can result in a substantial reduction in the amount of 'in-house' material that needs to be produced.

The other approach (seeking new methods of storing, altering and delivering our material, without significantly compromising its effectiveness) is the one with which we personally have had more experience, experience that has been put to use most recently on a course which is the first in our institution to employ 'new technologies' such as word processing. (The use of such technologies should not be taken as representing any change in official University policy; any opinions we express on the merits and implications of such technologies are our own.)

But before we report on our experiences with that course, we should like to provide a little background information: as in most large organisations, the Open University makes extensive use of computers for administrative purposes. In addition, we make use of both large time-sharing computers and microcomputers for teaching and research. (Our Student Computing Service, for example, supports terminals in approximately 200 study centres, spread across Britain.)

This has led to the development of considerable computing expertise among our staff, making practicable an OU Prestel-type information system, and allowing the OU to produce special 'Cyclops' attachments for television sets, which enable us to provide simultaneous computer-assisted learning and telephone instruction, interactive 'screen-based' tutorials etc.

If the cost of such equipment continues to decrease at the current rate, it may be feasible within 2-3 years to use an entirely electronic 'closed system' for producing and delivering certain types of course material. Such an information-handling system is likely to be highly competitive with our current paper-based system, when short print-runs are envisaged.

The OU is, of course, not alone in thinking about such systems: references to 'the office of the future' and 'the library of the future', - with their vision of electronic typewriters, with 'electronic mail' facilities, linked to an information network - are by now commonplace. Whether they represent an economic reality is another matter, but companies like Exxon seem to be well on the way to making them a technical reality, by integrating their various product lines (QYX electronic typewriters, QWIP facsimile, DIALOG word recognition, DELPHI voice communication, VYDEC editing terminals and ZILOG microprocessors).

To avoid any feeling that this is a 'sales pitch' for one company, we must state that several other companies, such as IBM and Philips, are pursuing a similarly impressive integration of their own products, (including, in Philips' case, private Viewdata terminals, compatible with Prestel, but with additional 'fool-proof' features and digitisation of pictures with full TV resolution), while some software houses are selling packages to enable Viewdata users to access non-Viewdata users to access non-Viewdata bases.

However, we note in passing that what is less impressive is the lack of agreement on compatibility 'protocols' (software functions that define how one computer can 'converse' with another): while some agreement has been reached on 'low-level protocols' (for the physical interlinking of networks), such as X25 for packet-switching, there is far less agreement on 'high-level protocols' (defining a computer's specific work functions). This agreement is vital since it determines how data are presented, how files are transferred, and how graphics or facsimile documents are transmitted.

What is perhaps as significant as the advent of any 'office of the future' is the large investment that some manufacturers (e.g. IBM, Philips, Xerox) have made in

long-term research projects to extend or augment the capabilities of human users of such systems.

Xerox, for example, has a Learning Research Group that has spent the last decade developing what they term a 'Dynabook'. Sometime in the 1980's this is to be a cheap, portable, computing facility, the size of a notebook, consisting of a high-resolution graphic output device with touch-sensitive surface, pen-like pointing device and audio-output capability. One objective of the Xerox group is to retain the advantages of paper as a medium for writing, note-taking and document production, but to combine this with the reactivity of a computer terminal, so that it becomes a new communications tool, based on the retrieval of dynamic information.

The current version of the Dynabook - the 'interim Dynabook', or 'Alto' - is not yet portable, although it has many of the other features referred to. The quality of displayed text is quite good; different fonts can easily be used; it has an extensive filing system which can be used to cross-index several thousand records; hard copy can be provided via a xerographic laser printer; it can animate illustrations at rates of up to 10 f p s and its editing facilities are suitable for both pictures and text. (The editing menu includes self-explanatory commands such as 'face', 'size', 'black', 'white', 'cut', 'paste', 'copy', 'repeat', 'line', 'arc' and 'track', and operates within 'windows' on the screen, which can overlap or change, according to commands like 'under', 'over', 'grow' and 'move'.)

Such a machine represents a considerable advance on the all-purpose desk-sized electronic and micrographic information resource that was described in 1945 by Bush in an oft-quoted article. That machine - the 'Memex' - was to be capable not only of displaying vast documentation files at the user's command but also of adding (to each document that was consulted) the user's annotations and 'trail' through the document. Exciting as the Memex concept was, the advanced office systems and publishing systems that will be marketed in the 1980's will go beyond it by adding a communications ('networking') capability; support of tasks involving analysis and decision-making; and some means of transforming the symbols in its memory (e.g. transforming verbal information to tabular, or tabular to graphic).

The significance of these developments can perhaps be gauged with a few general examples; as soon as we have given these examples, we shall return to the educational applications which we have experimented with at the OU. Our examples are drawn from information science, and illustrate three roles expected of such systems: acceleration, augmentation and delegation.

Information systems are built and used in the expectation that the system will perform information tasks that users either cannot perform or prefer not to perform. The first role, acceleration, is the familiar one of speeding up the acquisition of a given piece of information. The problem might be to identify all potential competitors of a book which you are considering publishing. Referring to the index in 'Books in Print', or to publisher's catalogues, would be one way of doing it, but if either of these sources of information were available in a computer data-base, there could be a substantial time saving.

The second role, that of augmentation, describes ways of assisting a user in the substance of the task, rather than the pace of the task. There are two related senses in which tasks can be augmented - 1 the time saving can be so substantial (seconds for a task, rather than hours) that a user decides to attempt a task - with assistance - that would be forgone without assistance; or 2 a task is not just a matter of time, but requires greater perseverance or alertness - or other perceptual or cognitive traits - than humans are capable of.

An example of the first kind of augmentation would be the tabulation and statistical analysis of large amounts of data; without computer assistance such tasks would be quite unmanageable. The second kind of augmentation would involve tasks which would normally cause 'information overload', such as searching through a large collection of documents, for papers which contain particular combinations of topics. (This is not a trivial task, even with computer assistance: if a database is to be reliable, each item in it will need to have been indexed in a consistent fashion using a very tight thesaurus of 'descriptors' - generic subject area indicators - and 'sub-descriptors'; if the database program is to support browsing or allow 'key word searches', this may require the addition of synonyms and homonyms, and yet more pre-indexing.)

The third role, delegation, is one in which the system itself uses programmed criteria to make the decisions which a user would otherwise make. A non-contentious application would be 'helping a user to fill in a form': if the form is the conventional sheet of paper, it will be unable (1) to sense what parts of the form have been completed; (2) to evaluate the content; or (3) to relate the content to files held elsewhere. On the other hand, if the form is displayed on the screen of a computer terminal the computer can give considerable assistance - provided, of course, that it bows to the vagaries of the user (eg some people may fill forms in from top to bottom, others from bottom to top). Systems which are designed to cope with this are sometimes termed 'humanised input' systems, for they can guess, for example, that an input of SEPT 10 is a date (for obvious reasons), and will transfer it to the most appropriate part of the form.

'Delegatory' systems exist - or are under development - which are capable of making decisions of considerably greater import. These decisions can be made via one of three procedures: according to rules that the system itself stipulates ('expert' systems, already finding applications in areas as diverse as medical diagnosis and mining exploration); according to decisions that a majority of the system's users have made in similar contingencies in the past; or according to decisions that the individual who is delegating responsibility has made in similar contingencies in the past.

One feature which is common to the majority of delegatory systems is that artificial intelligence procedures are applied to 'train' the system to perform the delegated function (eg interpretation of house style). If it has learned sufficiently well by experience, its decisions can rival or surpass those of the user.

These advances in hardware and software, then, were the technological developments which we were aware of, or had access to. But which were most relevant to educational publishing? And who might be affected by their introduction in the Open University? Those were the questions that we asked ourselves some two years ago, and we shall now attempt to give you our answers.

We were aware that most innovations in the work pattern of organisations begin by causing difficulties. The first-time user is likely to suffer from information overload and from the consequences of errors. However, we were encouraged to proceed for two reasons: (1) the University was already exploring the possibilities of new communication systems (eg digital cassette vision; domestic computer terminals; electronic blackboards; telephone teaching; video-cassettes; Viewdata, Ceefax and Oracle); (2) the reduction in cost of first-generation word-processors, and the availability of more advanced systems, made feasible a 'text-processing' system, which could not only be linked to any other communications devices, if required, but could also go beyond the 'solicitor's office' use of word-processors, by embodying some of the 'acceleration', 'augmentation' and 'delegation' roles previously referred to.

That there was a need for these extra features was clear from two standpoints: factors such as the maintenance load, need for academics to conduct research, etc. mean that our staff have proportionately less time available for producing new courses, or for evaluating their educational effectiveness; and our students seem to require more attention than previously, for the student body contains noticeably fewer teachers and other professionals than in 1969. This heterogeneity in our audience is gratifying in one sense - for it means that the University is now more 'open' - but it does present us with requirements for more skilful pedagogy, requirements that it is difficult to envisage being satisfied without recourse to additional staff or computer-assistance.

In addition, any system which we introduced had to be appropriate for the University's 'rational planning' approach to course production, with its four interlinked stages of 'establishing goals'; 'producing drafts or pilot programmes'; 'evaluation by course-team members, trials with students, etc' and 'revision' (figure 1).

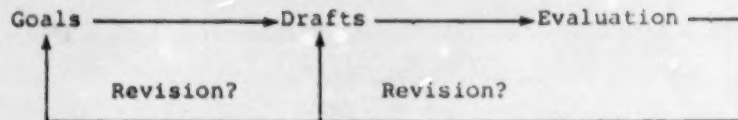


Fig 1 The 'systematic' or 'rational planning' approach.

Word-processing is, of course, quite an advantage in speeding up the re-drafting process; our typists were soon able to use editing commands like 'insert', 'delete', 'move', 'find' and 'merge', in the confidence that previously checked material need not be re-typed.

However, we have found major advantages in using computers at the evaluation stage - but we must set this in context by first giving a little background on the evaluation schemes which have traditionally been used at the Open University for the pre-printed (draft) versions of our courses.

Most course material goes through several drafts, and is commented upon first by course team members, as well as by potential tutors and by external assessors. Such comments concern the length, standard (or appropriateness) and clarity of the material. The 'academic standard' comments can be roughly broken down into comments on validity, breadth/depth and representativeness. The 'probable teaching effectiveness' comments are directed toward the length and 'tutorability' of the material, as well as its structure, style, syntax and general presentation.

Some courses also make use of student comments; students are either paid (when only parts of a course require such attention) or they receive the whole of a course, but are unpaid. In the latter case, they will study the course in as near its final form as possible, and will receive a 'credit' if they pass the exam and submit the appropriate assignments. This 'developmental testing' typically takes place with a group of between 25 and 35 students, who receive remission of fees if they respond to feedback questions which they encounter at strategic points in their study.

As can probably be imagined, an unaided course team can be overwhelmed by the amount of information which can be obtained by using all these schemes, in spite of their acceptance of the maxim "if it's worth printing, it's worth evaluating". This is perhaps why the course in which our text-processing system was applied is not only the first to use 'new technology' (including a brief flirtation with Kurtzweil's artificial-intelligence based optical character recognition), but is also the first to use all the evaluation schemes currently available.

In part, this is due to the time-saving which word-processing produced - a time-saving which, it must be said, was not immediately won, for we had our share of teething troubles, overcome only by hard work by our colleagues. However, the text-processing facilities are perhaps more interesting, for they allow considerable augmentation of our evaluative activities: it is fairly simple to conduct some computer-aided preliminary editing, whereby a typist, author or editor can be alerted to words which are misspelled; misused (or confused with others); overused or misinterpreted; and to phrases which are misinterpreted or wordy.

Another augmentation role is in style guides for copy-editing. Authors, secretaries or trainee editors may find it difficult to establish which graphic and spatial devices are appropriate to a specific language need, since many style guides are both poorly organized and badly written. A computer can help by redefining the style issues in terms of their language function, and by listing the constraints or other determinants. Typical language functions include: abbreviation; emphasis; interpolation; presentation of numbers and quotations, while typical determinants include: access structures (contents; index; headings); composition systems and component parts of text (particularly non-prose elements such as algorithms, decision tables, photos, etc, each of which has to be checked against its own special principles of construction and against its purpose). If this checking is done 'interactively', all examples of a particular problem can be presented at one editing session, virtually guaranteeing consistency. Some of the simpler issues a copy-editor has to face can even be

delegated, eg a text that does not follow BSI recommendations for using hyphens (plus spaces) to represent dashes (such as the em or en space) can be converted to the approved form quite quickly by a computer.

What is less simple - but promising, as we are finding out in small-scale experiments - is automatically assessing the 'readability' of material.

To us 'readability' is more than the application of formulae like the Flesch Index. It concerns the vocabulary of the reader, the way that 'signalling words' ('thus, because, hence...') are used to indicate arguments, the relationship of new information to information on previous pages, and other matters of rhetoric. This is one of the areas in which computerised 'content analysis' (word-counting and classifying) could be of great help - not in the sense of producing a 'star rating' of units, but rather for 'mapping' features of a text thereby alerting authors or editors to probable lack of cohesion or inconsistent cross-referencing, or to stylistic factors such as: degree of abstractness; explicitness; congeniality and authority.

It would be interesting to correlate such measures with measures obtained from student feedback. Such feedback can cover performance on assignments or activities; perseverance; enjoyment; ease at following arguments; comfort in knowing what tasks to anticipate; ability to plan reading; use made of practical examples and even word associations made by students, which have been proposed as an indicator of 'entry knowledge'.

Indeed, one of us (P W) has devised a reading-recorder which students can use at home as part of their normal study pattern. This microprocessor-based device is relatively unobtrusive, and gives a computer-analyseable record - a 'protocol analysis' - telling us which pages the students read, in which order, and for how long. Those familiar with studies of reading will know that reading-recorders are also used to study eye-movements across a page (or a double-page spread).

This is of particular significance to us, since the Cyclops system previously referred to allows us to digitise illustrations and transfer the 'picture files' to our text-processor, where their size or shape can be altered, and where they can be merged with text files. In other words, such a system allows its users to treat the whole (electronic) page as a diagram made up of a series of 'windows'. Those windows could contain text or representations of illustrations, and their relative size, shape and position could be altered electronically until an aesthetically pleasing arrangement is found. A trial paste-up of this layout could then be made - and evaluated with a group of students, to see if the initial aesthetic judgement is educationally effective.

But computer-assisted page layout can go much further than this, as shown by texts such as 'Book Design-systematic aspects' (B Rice, 1978). Although we have had little experience with this, we have seen examples of the successful computerisation of standardised design methods (grid formats, house-style, etc), which embody checks for the consistency of the 'visual grammar', to ensure that symbols always mean the same thing (isotype, graphs, tones etc).

It should be clear, then, that computers will assume an increasing importance in the production and dissemination of educational material, and may affect authors, secretaries, editors and designers. Whether this should be encouraged or resisted is a moot point, but we hope we have convinced you that there can be educational advantages in their use, as well as economic ones.